APHIDS AND THEIR PARASITES ASSOCIATED WITH OAKS IN IRAQ

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ABSTRACT—Aphids, parasites and aphid-attending ants found on oaks are reviewed and divided into several groups in accordance with their ecological niches. Interrelationships in the oak forest community and relationship to other communities are dealt with. Deforestation has been ascertained to affect deeply the composition and occurrence of aphids and parasites. The problem of the Kurdish "Manna" is dealt with. Some aphid species seem to be pests of oak scrub. *Trioxys* (*Trioxys*) **quercicola**, n. sp. (Hym., Aphidiidae) is described.

Oak forests are very old communities in Iraq. The exploitation of forests and deforestation of large areas since very ancient times has caused a considerable decrease in original areas and deep changes in present forests. Reforestation and associated problems represent one of the long-term research topics in Iraqi silviculture. Although there is no doubt that the deforestation is due to the activities of man (mostly uncontrolled wood-cutting, charcoal-burning, etc.) the research on fauna associated with oaks represents a necessary part of a complex research. The emphasis of this paper is on aphids and their parasites.

I am indebted to the authorities of the Biological Research Centre, Council of Scientific Research, Baghdad, for supporting this research. My thanks are due to the following specialists for the identification of material: Dr. J. Holman and Dr. J. Pintera (aphids), Dr. J. Pisarski (ants). Plants were kindly identified by the Staff of the Agric. Res. Station, Min. Agric. Iraq, at Abu-Ghraib, Baghdad, and by Prof. Dr. E. Hadač.

OAKS (*Quercus* spp.) AND THEIR DISTRIBUTION IN IRAQ

Guest and Al-Rawi (1966) divided the oak forests of Iraq into three groups according to their specific composition and vertical distribution.

1. Lowest zone.—*Quercus aegilops*. This is the lowest and driest sub-zone of the forest. *Q. aegilops* is the dominant tree, with a larger or smaller admixture of other oaks (*Q. infectoria*) or trees (*Pistacia*).

2. Medium zone.—*Q. aegilops* and *Q. infectoria*. These two species are co-dominant.

3. Highest zone.—*Q. infectoria* and *Q. libani*. This zone ranges from about 1200 to 1800 m, where the two mentioned species are co-dominant.

In most areas of the Kurdistan mountains the oak forests have been deeply affected by the activity of man. A varying degree of deforestation can usually be found: either the place has been completely deforested and reduced to steppe conditions, or there is oak scrub

around the stumps of cut trees, or old trees are present. The oak forests in Iraq are generally open, the steppe widely penetrating into them. Closed oak forests are reported to be found only in less accessible parts of the territory. Old oak trees, even in a deforested area, may usually be found in or near villages (Moslem cemetaries).

Our studies were undertaken mostly in the zones 1 and 2.

Review of the Aphids

Lachnus sp. (Lachnidae).

Biology.—A holocyclic monoecious species associated with *Quercus* sp. in Iraq. It occurs mainly on young shoots, feeding on the smooth bark, but also on the lower side, upper side and petiole of nearby leaves. Young shoots at the base of old trees and oak scrub are clearly preferred, whereas in the tops of old trees this species seems to be rare. Its colonies can be found in shaded and semi-shaded niches as well as in those exposed to sunshine, but a certain tendency to avoid too intensive sunshine by migration to the opposite shaded part of the stem has been observed. In the initial phase of the development of a colony the aphids—mostly alate virginogeniae—can be found isolated (fig. 9), but soon the colony becomes more numerous (fig. 10). With the exception of early instars, the aphids in a colony are never found very close to each other; a certain distance is strictly kept and larger colonies are relatively widely dispersed over an oak shoot. The damage caused to the oak seems mainly to be through sucking of plant juices and by production of honeydew. Young oak shoots seem to suffer most, both because of greater aphid abundance and lower quantity of juices. The aphid is a big producer of honeydew; leaves under and near the colonies are covered with honeydew, the drops of which fuse together and gradually accumulate near the petiole, where relatively large drops can often be observed. The aphid was found to be very abundant on the young shoots of old trees and especially of oak scrub.

Material examined.—*Quercus aegilops*: 6 km Salahuddin to Shaqlawah, Kurdistan, 10-7-68 (Starý); Salahuddin, nr. Shaqlawah, Kurdistan, 10-7-68 (Starý); Sari Rash, nr. Salahuddin, Kurdistan, 10-7-68 (Starý). Note: numerous samples were taken.

Parasites.—No parasites of this species have ever been observed, although a considerable number of aphids has been reared. A similar situation is known to occur in Europe, where *Lachnus roboris* L. is completely free of parasites.

Ant-attendance.—The aphid was very frequently attended by various species of ants, and it seems to be much preferred to the other oak aphids: *Acantholepis* sp., *Camponotus kurdistanicus* Em., *C. gestroi creticus* For., *C.* sp., *Cataglyphis protuberata* Crawl., *Crematogaster auberti jehovae* For., *Pheidole pallidula arenarum* var. *orientalis* Em., *Tapinoma simrothi karavaievi* Em.

Hoplochaetaphis zachvatkini (Aizenberg et Moravskaya) (Callaphididae).

A single specimen was collected on oak scrub. No detailed information was obtained.

Material examined.—Sari Rash, nr. Salahuddin, Kurdistan, 10-7-68, on *Quercus aegilops* (Starý).

Myzocallis picta (Ferrari) (Callaphididae).

Biology.—This is a holocyclic monoecious speciea associated with *Quercus* spp. in Iraq. Its ecological niche is very strictly defined as the aphids can be found solely on the upper side of old leaves in shaded parts in the top of old oak trees. The aphids are almost isolated; usually we did not find more than 1 or 2 aphids per leaf. The aphids are usually found sucking at the central rib of the leaf, not far from the basal third. The early instar aphids usually can be found a little closer to the virginogenia. If more aphids occur on a leaf, they keep a considerably wide distance apart (fig. 4), so that if we speak about a colony, it is widely scattered. It seems that practically no damage is caused to the attacked leaves through sucking. The production of honeydew is very low and only small droplets can be found on nearby leaves. The aphids were very rare in the studied localities.

Material examined.—*Quercus aegilops*: 6 km Salahuddin to Shaqlawah, Kurdistan, 10-7-68 (Starý); Salahuddin, nr. Shaqlawah, Kurdistan, 10-7-68 (Starý).

Parasites.—No parasites of this aphid were reared.

Ant-attendance.—Not observed.

Tuberculoides sp. (Callaphididae).

Biology.—A holocyclic monoecious aphid associated with *Quercus* sp. in Iraq. It is found on the lower side of older leaves in various parts of the tops of old trees. The colonies are scattered (figs. 5, 13). The damage caused to the leaves seems to be low. The production of honeydew is low; only small droplets can be found on leaves under a colony. The aphid is not rare on the old oaks.

Material examined.—*Quercus aegilops*: Salahuddin, nr. Shaqlawah, Kurdistan, 10-7-68 (Starý). *Quercus infectoria*: Salahuddin, nr. Shaqlawah, Kurdistan, 10-7-68 (Starý).

Parasites.—*Aphelinus* sp., *Praon flavinode* (Hal.), *Trioxys pallidus* (Hal.). In some cases, several mummies were found on a single leaf, being dispersed in the same way as live aphids (fig. 13).

Ant-attendance.—Not observed.

Thelaxes suberis (del Gu.) (Thelaxidae).

Biology.—This is a holocyclic monoecious aphid associated with *Quercus* sp. in Iraq. It occurs on young leaves, mostly on their lower side, but if the colony is more numerous the aphids can be found even

Fig. 1. Oak forest, environs of Salahuddin near Shaqlawah, Kurdistan. Fig. 2. Same, deforested area, with oak scrub around stumps.

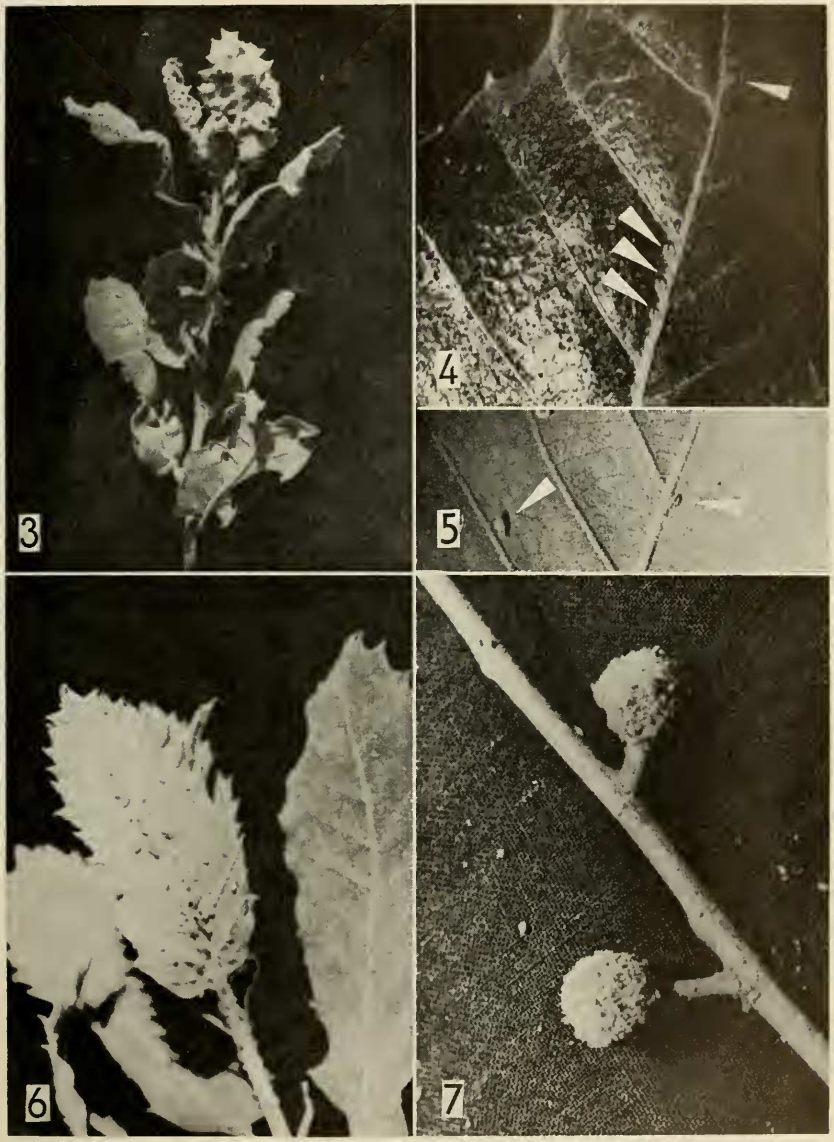


Fig. 3. Curling of a young oak shoot by *Thelaxes suberis* (*Quercus aegilops*). Fig. 4. *Myzocallis picta* on upper side of leaf of *Q. aegilops*. Fig. 5. *Tuberculoides* sp. on lower side of leaf of *Q. infectoria*. Fig. 6. *Thelaxes suberis* on shoot of *Q. aegilops*. Fig. 7. *T. suberis* on acorns of *Q. aegilops*.

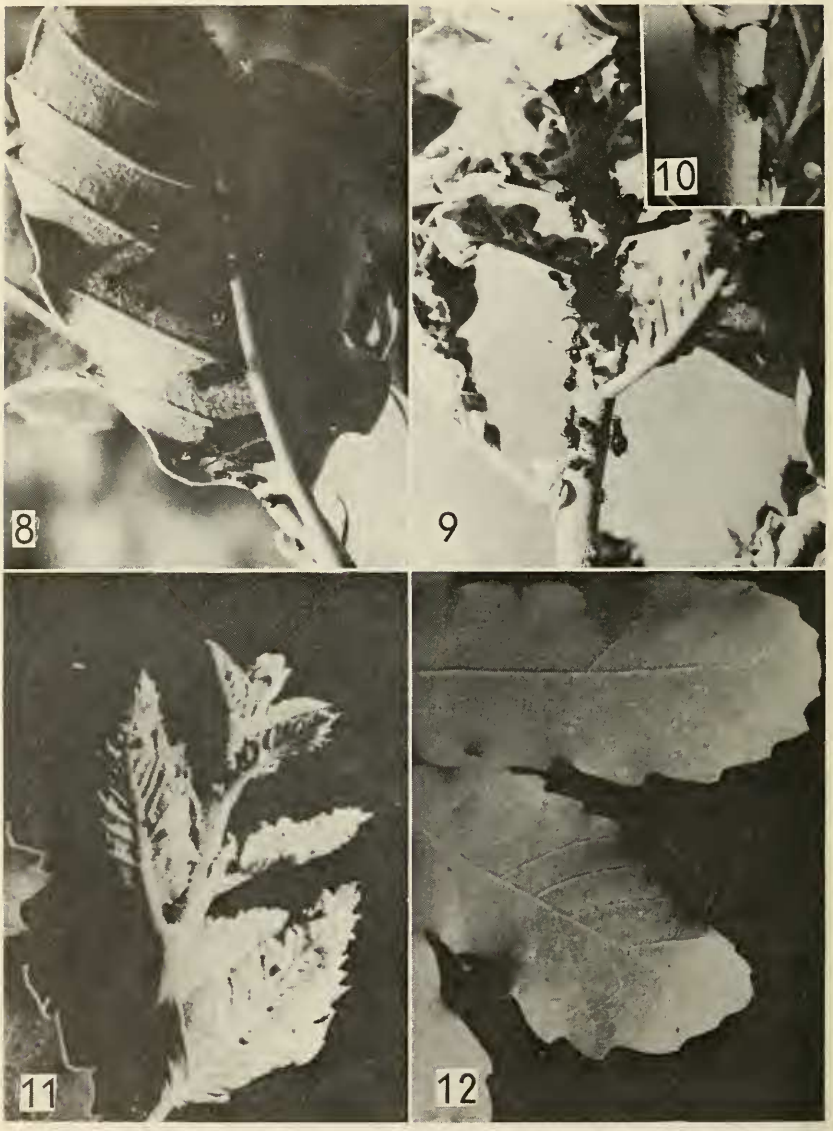


Fig. 8. *Lachnus* sp. on lower side of leaf of *Quercus aegilops*. Fig. 9. *Lachnus* sp. on young shoot. Fig. 10. *Lachnus* sp., alate virginogeniae. Fig. 11. *Thelaxes suberis* on young shoot of *Q. aegilops*, mummified by *Lysiphlebus thelaxis*. Fig. 12. *Phylloxera* sp. on lower side of leaves of *Q. infectoria*.

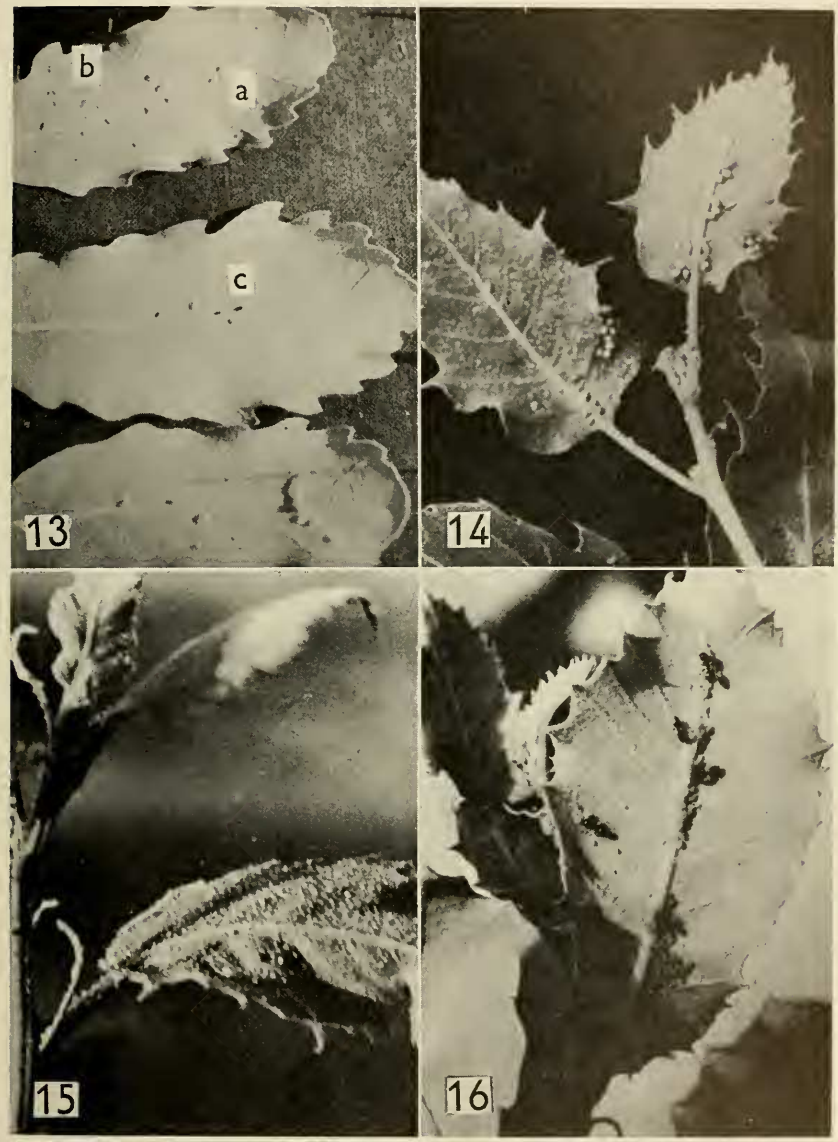
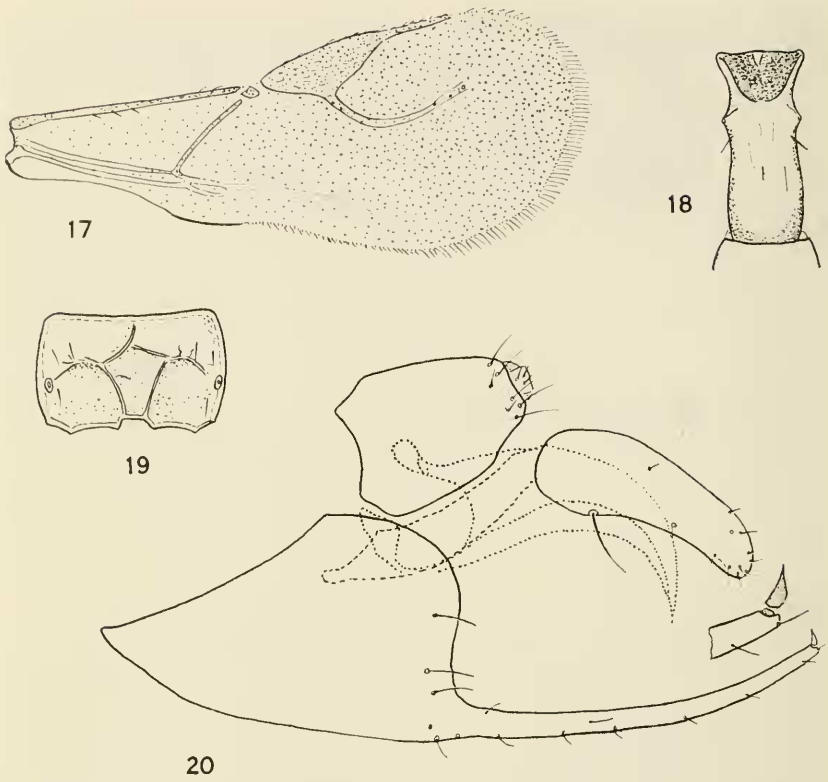


Fig. 13. *Tuberculoides* sp. on lower side of leaves of *Quercus infectoria* mummified by (a) *Trioxys pallidus*, (b) *Praon flavinode*, and (c) *Aphelinus* sp., small black mummies. Fig. 14. *Thelaxes suberis* on *Q. infectoria*, high percentage of mummies (*Trioxys quercicola*) in colony. Fig. 15. *T. suberis* on *Q. aegilops*, young shoot, showing "Manna" or drops of honeydew on upper side of leaves. Fig. 16. *T. suberis* on lower side of leaves of *Q. aegilops* showing ant-attendance by *Tapinoma simrothi karavaievi*.



Figs. 17–20. *Trioxys* (*Trioxys*) *quercicola*, n. sp., ♀ paratype: 17, fore wing; 18, abdominal tergite I; 19, propodeum; 20, genitalia.

on the upper side and petiole. The developing colony is at first concentrated along the central rib; later the lateral ribs are attacked as well as the nearby surface. The colonies are very dense and in bigger colonies—due to the close mutual attachment of aphids—it appears that the aphids occur in several layers. Young acorns can also be attacked, the aphid colonies covering the whole surface (fig. 7). The aphid obviously causes certain damage to the attacked leaves and shoots. We observed heavy curling of leaves on many of the attacked shoots (fig. 3), but in other cases the attacked leaves were quite normal (fig. 6). Consequently, the question still remains whether the aphid itself is responsible for the curling. The aphid is a big producer of honeydew. The nearby leaves are covered first by small drops, which later fuse and form large drops which usually can be found at the base of leaves and later fall to the ground. The aphid was very abundant, particularly on the young shoots of old trees and on oak

scrub; its occurrence in the top of old trees seems to be less common (acorns).

Material examined.—*Quercus aegilops*: Tadzhike, nr. Sarsang, Kurdistan, 24-5-68 (Starý); 6 km Salahuddin to Shaqlawah, Kurdistan, 9 and 10-7-68 (Starý); Salahuddin, nr. Shaqlawah, Kurdistan, 10 and 11-7-68 (Starý); Sari Rash, nr. Salahuddin, Kurdistan, 10-7-68 (Starý). *Quercus infectoria*: Sarsang, Kurdistan, 24-5-68 (Starý). Note: numerous samples were taken.

Parasites.—*Lysiphlebus thelaxis* Starý: mummies were observed in many colonies; in some of them even the aphids at the youngest leaf on the top were mummified. *Trioxys quercicola*, n. sp.: found in a single sample taken from an old tree.

Ant-attendance.—The aphid is attended by several species of ants: *Acantholepis* sp., *Camponotus kurdistanicus* Em., *C. gestroi creticus* For., *C.* sp., *Crematogaster auberti jehovae* For., *C. sordidula mayri* Mayr, *C.* sp., *Pheidole pallidula arenarum* var. *orientalis* Em., *Tapinoma simrothi karavaievi* Em.

Phylloxera sp. (Phylloxeridae).

Biology.—A holocyclic monoecious species associated with oaks in Iraq. It occurs on old leaves, exclusively on their lower side. Only the leaves in the tops of old trees were attacked; the aphid was never observed on oak scrub. The aphids in colonies are dispersed, but many specimens can be found on one leaf. Their sucking causes the development of small reddish-orange spots around each aphid (fig. 12). The production of honeydew by the aphid is very low and only a very thin sticky cover can be found under the infested leaves. The occurrence of this aphid was rare.

Material examined.—*Quercus aegilops*: Salahuddin, nr. Shaqlawah, Kurdistan, 10- and 12-7-68 (Starý).

Parasites.—No parasites were reared. The group does not seem to be attacked by the parasites at all.

Ant-attendance.—Not observed.

Another phylloxerid species was found on *Quercus aegilops* scrub in Sari Rash, nr. Salahuddin, Kurdistan, 10-7-68 (Starý) and 6 km of Salahuddin to Shaqlawah, Kurdistan, 9-7-68 (Starý).

Review of the Parasites

Aphelinus sp. (Aphelinidae).

Biology.—The larva pupates inside the parasitized aphid. The coloration of the mummy is black. The parasite female seems to prefer early instar aphids as the larvae mummify the aphids before they reach maturity. The dispersal of the mummies corresponds to that of live aphids. The mummies were found on the underside of leaves in

various parts of the tops of old trees. No attendance of the mummies by ants was observed.

Material examined.—*Tuberculoides* sp.: Salahuddin, nr. Shaqlawah, Kurdistan, 9-7-68, *Quercus infectoria* (Starý).

Host range.—Unknown.

Lysiphlebus thelaxis Starý (Aphidiidae).

Biology.—The fully grown larva pupates inside the mummified aphid. The coloration of the mummy is yellowish brown and becomes lighter when the mummy is older. The mummies were found dispersed in the colonies of live aphids, never occurring in dense groups; obviously, there is a certain egg dispersal by female parasites. The mummies were found both on the underside and upperside of leaves in old trees, scrub and young shoots. Mummies were observed to be attended by ants in the same way as the live aphids.

Material examined.—*Thelaxes suberis* (del Gu.): Salahuddin, nr. Shaqlawah, Kurdistan, 10-7-68, 11-7-68, *Quercus aegilops* (Starý); 6 km Salahuddin to Shaqlawah, Kurdistan, 9-7-68, *Quercus aegilops* (Starý); Sari Rash, nr. Salahuddin, Kurdistan, 10-7-68, *Quercus aegilops* (Starý). Note: this species was reared from numerous samples.

Host range.—The species is a typical parasite of *Thelaxes* spp. in deciduous and mixed forests. It is known from Europe; its occurrence in the Kurdistan mountains seems to be an extension of the Mediterranean part of its distribution.

Praon flavinode (Haliday) (Aphidiidae).

Biology.—The larva pupates in a separate cocoon, the empty aphid skin being mounted on its top. The cocoon is whitish, the aphid skin is translucent. Mummies were found to be dispersed over the lower side of leaves in the same manner as the live aphids in various parts of the tops of old trees. No ant-attendance was observed.

Material examined.—*Tuberculoides* sp.: Salahuddin, nr. Shaqlawah, Kurdistan, 10-7-68, *Quercus infectoria* (Starý).

Host range.—The species is known as a parasite of quite a number of dendrophilous callaphidid aphids in Europe; it was also introduced to some other areas. It occurs in deciduous and mixed forests; its occurrence in the mountains of Kurdistan is obviously an extension of the Mediterranean part of its distribution.

Trioxys pallidus (Haliday) (Aphidiidae).

Biology.—The fully grown larva pupates inside the mummified aphid. The coloration of the mummy is yellowish and becomes yellowish-white when the mummy is older. The mummies were found dispersed on the underside of leaves in the same way as live aphids.

They were found in various parts of the tops of old trees. No ant-attendance was observed.

Material examined.—*Tuberculoides* sp.: Salahuddin, nr. Shaqlawah, Kurdistan, 10-7-68, *Quercus infectoria* (Starý).

Host range.—It is known as a parasite of a number of dendrophilous callaphidid aphids. It is distributed from Europe to the Caucasus, Central Asia and Asia Minor, being also introduced to other areas. It occurs in deciduous and mixed forests and orchards (walnut). Also it was reared as a parasite of *Chromaphis juglandicola* (Kalt.) on walnut in a riverain forest community in Kurdistan (Iraq).

Trioxys (Trioxys) quercicola, n. sp. (Aphidiidae).

Diagnosis.—It is related to *T.* (*T.*) *pallidus* (Haliday) and similar species by having 1 dilated claw-shaped bristle at the apex of prongs. It can be easily distinguished from its relatives by slightly curved prongs and lack of hairs on their dorsal surface.

Female.—Head subquadrate as seen from above, arcuately narrowed beyond the eyes to the occiput, smooth, shiny, sparsely hairy, as wide as thorax at tegulae. Face smooth, shiny, with several hairs near the orbits. Clypeus suboval, frontally margined, slightly convex, separated from face by a shallow, narrow and arcuate groove, with a deep and small tentorial pit on either side. Tentorio-ocular line equal to ⅕ of intertentorial line. Eyes long, oval (3:4), frontolaterally prominent, convergent with the clypeus. Antennae 11-semented, filiform, reaching nearly to middle of abdomen; F_1 equal to F_2, slightly more than three times as long as wide. Socket-ocular line equal to half the socket-diameter.

Mesoscutum falling vertically to the prothorax. Notaulices narrow, deep, slightly crenulate; developed at the ascendant part of mesoscutum and effaced on the disc, at the end being traced by two long hairs to about the middle of the disc. Praescutellar groove arcuate and wide. Scutellum widely triangular, with sparse hairs. Propodeum (fig. 19) areolated, the central areola incomplete due to irregular carinae, with sparse hairs. Wing (fig. 17): pterostigma triangular, almost three times as long as wide; metacarp equal to half of the pterostigma-length; radial vein arcuate, equal to the length of pterostigma. Legs normal.

Abdomen lanceolate. Tergite 1 (fig. 18) almost parallel-sided, 2.5 times as long as wide at spiracles, smooth, shiny. Primary (spiracular) tubercles situated at the end of the first third, slightly prominent laterally. Following tergites smooth, shiny, sparsely hairy. Genitalia (fig. 20): prongs slightly arcuate, distinctly separated from each other, with 1 dilated claw-shaped apical bristle, without any long hairs on the dorsal surface.

Head brown black; clypeus, lower part of genae, mandibles (except darkened apexes) yellowish. Palpi yellow. Scape, pedicel F_1 and F_2 yellow, the rest of antennae brown. Thorax brown black; prothorax brown, lighter at the base. Propodeum brown. Wings hyaline, pterostigma and a part of venation yellowish-brown. Tegulae yellowish-brown. Legs yellow, praetarsi of all legs darkened. Abdomen yellow; ovipositor sheaths and prongs yellow.

Length of body about 1.4 mm.

Male.—Antennae 13-segmented. Coloration much darker than in the female.

Head black, mandibles, lower margin of clypeus and genae brownish. Antennae brownish. Thorax black. Wings hyaline, venation light brownish. Legs yellowish-brown, praetarsi darkened. Abdomen brown black, tergite 1 and basal spot at tergite 2 yellowish-brown.

Type.—Holotype ♀: Salahuddin, nr. Shaqlawah, Kurdistan, Iraq, 10-7-68, reared from *Thelaxes suberis* on *Quercus infectoria*, open oak forest (Starý). Deposited: Coll. Starý.

Allotype ♂: Topotypical, with the same data as the holotype ♀. Deposited: Coll. Starý.

Distribution.—Iraq (Kurdistan).

Habitat.—Mountain forests (Quercetum).

Material examined.—*Thelaxes suberis* (del Gu): Salahuddin, nr. Shaqlawah, Kurdistan, 10-7-68, on *Quercus infectoria*, open oak forest, old tree, holotype ♀, allotype ♂, paratype ♀ (Starý).

Host range.—Probably a strictly specialized parasite.

Note.—Mummified aphids are yellowish. In several cases dense groups of mummies were observed on the oak leaves and it seems that the parasite female is capable of ovipositing gradually in a number of aphids.

Review of Aphid-Attending Ants

Some of the oak aphids were found to be very frequently attended by various species of ants.

Acantholepis sp.: *Lachnus, Thelaxes.* It also attended other aphids (*Aphis, Chaitophorus*).

Camponotus kurdistanicus Em.: *Lachnus, Thelaxes.* Some other aphids (*Aphis*) were also attended.

Camponotus gestroi creticus For.: *Lachnus, Thelaxes.* It was found to attend only these aphids.

Camponotus sp.: *Lachnus, Thelaxes.*

Cataglyphis protuberata Crawl.: *Lachnus* sp.; no other aphids were attended.

Crematogaster auberti jehovae For.: *Lachnus, Thelaxes.* No other aphids were attended.

Crematogaster sordidula mayri Mayr: *Thelaxes.* No other aphids were attended.

Crematogaster sp.: *Thelaxes.*

Pheidole pallidula arenarum var. **orientalis** Em.: *Lachnus, Thelaxes.* Some other aphids (*Aphis*) were also attended.

Tapinoma simrothi karavaievi Em.: *Lachnus, Thelaxes.* This is the most common ant attending various aphids in Iraq (*Aphis, Hyalopterus, Pterochloroides, Chaitophorus, Lachnus, Thelaxes*, etc.).

Both *Thelaxes* and *Lachnus* belong to the group of aphids which are obligatorily attended by ants. The reason seems to be obvious as these two aphid species are producers of abundant honeydew.

As to the attendance-range of separate species of ants, most of them

exhibit a wide range including also other aphids, besides some oak aphids. Only some species associated with oak aphids were found to be specialized, but this is believed to be due more to our poor knowledge of their range than to their ecological pecularities.

As no parasites of *Lachnus* aphids were recognized, only the relationship of the ants to *Thelaxes* aphids mummified by *Lysiphlebus thelaxis* was dealt with. This relationship exhibited the common feature of ant-aphid-parasite relationship in that the mummies were ignored by ants and protected by them in the same way as the other aphids in the colony.

When collecting aphids and ants on the oaks, we have also observed an anthicid beetle (*Formicomus* sp.)[1] to occur in or near several aphid colonies. As this was not a single case, its occurrence should have a certain reason. Moreover, the general appearance of the beetle resembles very closely the *Tapinoma* ant. The beetles behaviour in aphid colonies was very similar to that of the ants, while its responses to adverse mechanical stimuli had solely the character of escape. The anthicid beetles are a group which occurs mostly in old wood and other organic material (litter, river banks, etc.). This was not the case of our observations. It seems that *Formicomus* sp. feeds on fresh or dry honeydew of aphids on the oaks.

Considering the fact that the ants disregarded the *Formicomus* beetles, a somewhat closer relationship seems to occur, the morphological resemblance of the former still supporting this opinion. The beetles were observed only on the oak scrub.

Ecological Niches of Separate Aphid Species and Associated Parasites

Ecological niches of aphids on oaks can be classified from several points of view, as listed below.

1. Age of the host plant: young plants (also shoots at the base of old trees)—*Thelaxes suberis*, *Lachnus* sp.; old plants—*Myzocallis picta*, *Tuberculoides* sp., *Phylloxera* sp., *Lachnus* sp., *Thelaxes suberis*.

2. Parts of the host plant: bark—*Lachnus* sp. (both on very young and older branches if the bark is smooth, not occurring on old bark); shoots—*Thelaxes suberis* (sometimes), *Lachnus* sp.; leaves—*Myzocallis picta*, *Tuberculoides* sp., *Phylloxera* sp., *Thelaxes suberis*, *Lachnus* sp. (sometimes); acorns (young)—*Thelaxes suberis* (sometimes).

3. Side of the leaf: upper side of the leaf—*Myzocallis picta*, *Thelaxes suberis* (sometimes), *Lachnus* sp. (sometimes); lower side of the leaf —*Tuberculoides* sp., *Phylloxera* sp., *Thelaxes suberis*, *Lachnus* sp. (sometimes); petiole—*Lachnus* sp. (sometimes), *Thelaxes suberis* (sometimes).

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[1] Identified through kindness of Dr. Jelínek.

4. Age of the leaf: young leaves—*Thelaxes suberis*, *Lachnus* sp.; old(er) leaves—*Myzocallis picta*, *Tuberculoides* sp., *Phylloxera* sp., *Lachnus* sp.

5. Vertical distribution of aphids on the host plant: trees, lower parts of the top—*Myzocallis picta*; trees, various parts of the top—*Tuberculoides* sp., *Phylloxera* sp., *Lachnus* sp., *Thelaxes suberis*; scrub, young shoots, upper parts—*Thelaxes suberis*, *Lachnus* sp.

6. Exposure to sunshine or shade: exposed parts, often in full sunshine—*Thelaxes suberis*, *Lachnus* sp.; shaded parts (in the tops of trees)—*Myzocallis picta*, *Tuberculoides* sp., *Phylloxera* sp., *Lachnus* sp., *Thelaxes suberis*.

The parasites were found to attack their host aphids in all the niches in which they occur. The only exception could be *Trioxys quercicola*, which attacked *Thelaxes* aphids only in the tops of old trees; nevertheless, more material should be dealt with.

Interrelationships in an Oak Forest Community

The evaluation of the parasite spectra of separate oak aphid species and host ranges of the parasites has clearly shown that each of the aphid species and its associated parasites represents an isolated food chain; the food chains are independent of each other except the influence of the common food source, the host plant. In *Lachnus* sp., *Phylloxera* sp., and *Myzocallis picta* the parasites were not established at all, so that we may suppose that their numbers are limited through the action of predators or other factors. *Thelaxes suberis* is attacked by strictly specialized parasites and a close population relationship may be expected to occur. *Tuberculoides* sp. is attacked by 3 species of parasites and their interrelationship in limiting the host population may be more complicated; moreover, some of the parasites can attack other hosts in other ecosystems.

The aphid-attending ants are not strictly limited to a certain food chain, but they are, nevertheless, connected with only some of the oak aphid species (*Thelaxes*, *Lachnus*), having no relation to the others.

Relationship of the Oak Forest Community to Other Communities

The open character of the oak forest in Iraq, the occurrence of steppe as the undergrowth, the close neighbourhood of those forests and the steppe character of damaged forests could indicate a certain relationship between the forest and steppe elements in the oak forest community. However, in aphids and associated parasites just the opposite is true. The oak aphids and their parasites are exclusively associated with the oaks and do not have any relationship to the steppe community. The research of aphids and their parasites occurring in the steppe has shown that they are represented mostly by *Dactynotus*,

Brachycaudus, *Aphis*, *Brevicoryne*, etc., and associated parasites. A single relationship has been found in aphid-attending ants which occurs both in the trees and steppe plants.

Only the parasite species attacking *Tuberculoides* sp. are more widely specialized, attacking a number of dendrophilous callaphidid aphids, and they also occur in the riverain forest communities. There, *Juglans regia*, the walnut, occurs naturally or is cultivated, being infested by *Chromaphis juglandicola* (Kalt); the latter aphid belongs in the host range of the mentioned parasites. They were also found to attack it in Kurdistan (Iraq).

Deforestation and its Influence on Aphids and Parasites

The cutting of oak trees represents a factor which deeply influences the oak forest community. The lack of suitable food and change of microclimate seem to be the main reasons. Aphids and associated parasites are a group that demonstrate well the influence of deforestation on the fauna.

Three types of oak forests may be distinguished in the Kurdistan mountains, with regard to deforestation.

1. Virgin oak forest. No trees are cut there. The old trees usually have a certain number of shoots near the base of the trunk. This type of forest seems to have a scattered distribution in the original open forest woodland because of considerable deforestation (fig. 1).
2. Cut oak forest, with oak scrub around the stumps (fig 2). This type means a changed forest, but if the shoots are left untouched by man (pastures, cutting), a new forest develops in the course of years. This seems to be the most common type recently in the oak forest woodland in Iraq.
3. Cut oak forest, with the stumps removed. This type represents a complete deforestation and basic change in the type of community. Re-forestation is possible only by artificial re-planting of such areas.

In the section on ecological niches we have shown how strict the distribution is of aphids and parasites over oak trees and/or scrub. In virgin oak forest community the distribution of aphids and parasites is typical as mentioned in the review of niches. In cut forest with oak scrub there is a lack of aphids associated with the tree layer, as they are incapable of living solely on the scrub. Thus, *Myzocallis picta* and *Tuberculoides* sp. are absent. On the contrary, the species connected with the oak shoots, i.e. *Lachnus* sp. and *Thelaxes suberis*, have found the oak scrub to be a quite suitable habitat and may be very common in such places. In entirely deforested areas there are no oak aphids at all, as all of them are strictly specialized to the oaks as their food source.

The occurrence of the parasites of oak aphids, which are mostly

specialized and connected with the occurrence of their host aphids, exhibits similar features. Although in the virgin oak forest all the parasites can be found, only *Lysiphlebus thelaxis* occurs in the oak scrub.

The aphid-attending ants were observed to be much more common on the scrub and shoots than in the tops of the trees. There seems to be two reasons for this: first, there are more aphids (*Thelaxes*, *Lachnus*) on the shoots and scrub than in the top; second, the distance from the ant nest is important. The mentioned features of ant occurrence allow us to conclude that the ants are more common in oak scrub forests.

Honeydew of Aphids and the Problem of "Manna"

"Manna" is a phenomenon characteristic of the more arid areas of the Middle East. Bodenheimer and Swirski (1957) paid considerable interest to this problem. According to these authors the mannas are classified as abundant excrements of sap-feeding aphids, coccids and cicadas, which harden and/or crystallize in dry air. The abundant manna-years are in hot and dry summers. The Sinai Manna of the Bible is the excretion in June-July of two coccids on tamarisks. The "mann-es sinah" (the manna of the skies) of the Kurdish oak forests from Elazig and Urmia to Sulemanyia is also mentioned as belonging to this group:

> "The first specimen obtained came from Elazig, looking like a whitish stone with abundant greenish inclusions. Only much later it was understood that this stone was actually the Kurdish manna mixed with many small fragments of oak leaves. We learnt at Shuarta that these "stones" are boiled and purified by pressing the liquid substance through cloth. Peasants consume the manna as a sweet with their breakfast, prepare from it sweet sherbet drinks and mix it with flour and nuts to make delicious cakes. J. Leibowitz (1943) analyzed two of our samples and described them as a half syrupy, half crystaline mass. Their dry matter contained 30% and 45% respectively of the rare dissachride trehalose, and 70% and 80% of the total were carbohydrates, the remainder being sucrose and invert sugar with an excess of glucose. Most of the manna usually appears in May–June, with some in autumn. Unfortunately, we did not discover any on two visits to Iraqi Kurdistan in 1943 and this could not verify which oak aphid species produces this manna . . . . We add some details from an unpublished report by Mr. Jafar al Khayat from Northern Iraq. He regards as the source of this manna a small green aphid; the manna begins to appear on the lower surface of the leaves, from where it drops to the upper surface of lower leaves and to the soil. It is collected in the early morning. Rainfall and warm cloudy weather decrease its production, cold winds increase it. The collectors cut the branches on which manna is abundantly formed. The branches are beaten until the manna has fallen off. Then it

hardens together with the tiny fragments of oak leaves with which it became mixed during the beating. This manna is preserved in skin bags and brought to the markets where the confectioners buy it. The local production sold on the market of Sulemaniya is estimated at about 10,000 kilos, and about 20,000 additional kilos are brought there from Northern Iraq."

The above description solves the problem of manna in many ways, but some significant information has been omitted. We paid attention to such gaps when dealing with the oak aphids as well. First, there is the question of which aphid species is responsible for such a big production of honeydew. We presume that we have collected most of the oak aphid species during our research in Kurdistan, at least the commonest species, so that there is no doubt that the main manna-producer is also included in the material. When we climbed the old trees, there was relatively little honeydew on the leaves, i.e. there were fine droplets on the upper side of the leaves but no large drops; there were the callaphidid aphids, *Myzocallis picta* and *Tuberculoides* sp., and *Phylloxera* sp. present in such trees. Larger drops of honeydew were found only on the leaves near or under the *Lachnus* colonies, but these aphids—as mentioned earlier—were not abundant in the tops of old trees. The same is true of *Thelaxes suberis*. Thus, the first important conclusion is that the callaphidids and *Phylloxera* do not produce much honeydew and since the *Lachnus* and *Thelaxes* aphids are rare there, the manna obviously can not be collected from the old oak trees. Quite an opposite situation was found in the oak scrub around the stumps of cut trees. There, a large number of drops were often observed on the upper side of leaves (fig. 15). In many cases there was a complete cover of small drops; in other cases, beside these small drops, drops of 0.5 to 1 cm in size were observed. Such big drops were mostly found at the bases of leaves, being obviously the result of gradual fusing of smaller drops or of honeydew excretion at one place by a large aphid colony. The big drops were also observed to fall down to lower leaves and to the ground as well. In many cases a large part of a shoot was covered with the honeydew. As to the aphids, *Thelaxes suberis*, which is obviously the "small green aphid" of Bodenheimer and Swirski (1957), and *Lachnus* sp. were present on such shoots and they consequently are considered to be the producers of honeydew (manna). Nevertheless, large quantities of honeydew were not found near or under each larger colony of those aphid species. Obviously, the physiological state of the plant, the period of day or year, and, last but not least, the ant-attendance play a certain role.

According to our opinion, the collecting of the manna may be detrimental to the development of new oak forests, especially if it is done without regard to the selection of shoots as the future young oak trees.

Economic Significance of Aphids and Associated Parasites

The aphids infesting oaks cause damage to the host plants in the following ways.

1. Sucking of plant juices. In older trees it does not seem to have a great significance. The infestation of the young acorns (*Thelaxes*) could be dangerous, but it seems to be less common. In the shoots (scrub) the sucking seems to be more significant.

2. Deformation of leaves. The aphids are most probably responsible for a heavy curling of leaves or curling of whole tops of young shoots (*Thelaxes suberis*, *Lachnus* sp). This curling is sometimes very common.

3. Reddish or yellowish-red spots on leaves. *Phylloxera* sp. is responsible for the appearance of small spots on the leaf-surface at the places of sucking. The aphid and, consequently, this type of damage seem to be rare.

4. Production of honeydew. Honeydew can cover a great part of the leaf surface and consequently cause the decrease in assimilation, etc., as it is known in other plants. Furthermore, various moulds may secondarily develop on such a substrate.

As to the economic significance of the damage caused to the oak trees it seems that the aphids are generally less important when occurring on old(er) trees. Nevertheless, they are very common and obviously can be classified as pests on young shoots. This is important for the development of new forests in deforested areas where oak scrub near stumps is common.

The role of parasites can be considered economically significant only in the case of *Lysiphlebus thelaxis*, which parasitizes the *Thelaxes* aphids infesting young shoots; the percentage of parasitization observed in the colonies (number of mummified aphids) is very high. *Lachnus* species, another pest, is not attacked by the parasites at all.

Host Plant—Aphid—Parasite List

Quercus aegilops L.

Lachnus sp.: no parasite.
Hoplochaetaphis zachvatkini (Aizenberg et Moravskaya): no parasite.
Myzocallis picta (Ferrari): no parasite
Tuberculoides sp.: no parasite.
Thelaxes suberis (del Gu.): *Lysiphlebus thelaxis* Starý.
Phylloxera sp.: no parasite.

Quercus infectoria Oliv.

Tuberculoides sp.: *Aphelinus* sp.
Praon flavinode (Haliday)
Trioxys pallidus (Haliday)
Thelaxes suberis (del Gu.): *Trioxys quercicola* n. sp.

Conclusions

1. The following aphids and associated parasites were found to occur on *Quercus* spp. in Kurdistan (Iraq): *Lachnus* sp. (0), *Hoplochaetaphis zachvatkini* (Aizenberg et Moravskaya) (0), *Myzocallis picta* (Ferrari) (0), *Tuberculoides* sp. (*Aphelinus* sp., *Praon flavinode* Haliday, *Trioxys pallidus* Haliday), *Thelaxes suberis* (del Gu.) (*Lysiphlebus thelaxis* Starý, *Trioxys quercicola* n. sp.), *Phylloxera* sp. (0).

2. Aphids and their parasites can be divided into several groups according to the ecological niches. The aphid-attending ants seem to be less specialized in this respect.

3. Each oak aphid species and associated parasites represent a separate food chain independent of each other except for the common food base. Ants attend several aphid species.

4. Deforestation has a basic influence on the composition and occurrence of aphids and parasites on oaks. There is a basic difference between the virgin oak forest, oak scrub and a completely deforested area.

5. The Kurdish "Manna" is originally the honeydew of *Thelaxes suberis* and *Lachnus* sp. It occurs on oak scrub, but it does not seem to be common on the top of old trees where also the mentioned aphids are rare. The aphids which occur solely in the tops of old trees (*Myzocallis picta*, *Tuberculoides* sp.) are neither great honeydew producers, nor are they abundant.

6. Aphids do not seem to have any economic significance in the old trees while *Thelaxes* and *Lachnus* can be classified as serious pests of young shoots (scrub) in newly developing (cut) forest areas.

7. Among the parasites associated with oak aphids only *Lysiphlebus thelaxis* can be classified as significant; it attacks the *Thelaxes* aphids occurring on young shoot (scrub), also in the newly developing (cut) forests and often achieving a high degree of parasitization. *Lachnus* aphids do not have parasites.

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THE NORTH AMERICAN SPECIES OF ARTHROLYTUS THOMSON (HYMENOPTERA: PTEROMALIDAE)

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ABSTRACT—A history of the genus *Arthrolytus* Thomson in North America is given, with redescription of *A. fasciatus* (Provancher), occurring in northeastern states, and description of *A.* **muesebecki**, n. sp., from California, reared from cynipid galls on oak.

Arthrolytus Thomson has had a curious history in North America. It was a quite commonly used chalcidoid generic name in the Nearctic literature for about 40 years, but passed out of use, and very recently has again been used.

Several European species of *Arthrolytus* had been known since 1878, but no Nearctic species were described until 1893. In that year Ashmead recognized what he took to be this genus from Ohio and described *Arthrolytus apatelae*. In 1894 he characterized another species, *A. pimplae*, from Virginia. Also in 1894 Ashmead transferred *Cleonymus clisiocampae* Fitch, described from New York state, to *Arthrolytus*. Thus, in the 1890's *Arthrolytus* had 3 Nearctic species, the names of which appeared in numerous economic reports, faunal lists, and catalogues, because they were often identified as primary or secondary parasites of common lepidopterous hosts. However, these names gradually disappeared from the literature.

In 1897 Howard synonymized *Arthrolytus clisiocampae* under the

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